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Lightweight

White Paper

# Lightweight

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ASSEMBLY  
TECHNOLOGY  
EXPERT

## LIGHTWEIGHT

# Preface

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The following article is written primarily for design engineers who are trained in mechanical engineering and/or deal with hardware decisions. The writer hopes to provide for a snap-shot of the current market situation on the topic of lightweight with the primary focus on new materials and fastening technologies to accommodate. That being said, we know that the technology is primarily market driven and will have exponential changes, making this a current snap-shot. The writer knows and hopes as well that this article will be extinct in a very short time. However, as my principle engineering guru used to say, "How much can the primary principles of fasteners differ over time, but they can always be fine-tuned to improve and meet targeted requirements".

The objectives of this article are to provide for an understanding of the challenges design engineers face daily at meeting design requirements with sufficient knowledge and understanding of fastener technologies. Most mechanical engineers will assume that fasteners are easy to come by and rightly so due to the vast availability of manufacturers and services available in the market. However, a fastener meeting the specific design expectations is a whole different ball game altogether. When assemblies using fasteners are left till the end, often special fasteners will have to be acquired to meet the expectations. The writer will scope this article on the topic of lightweight in association with fastening technologies. Here we go...

## Lightweight

When the word 'Lightweight' is mentioned often, what would be the immediate reactions? For Bossard perhaps it is hydrogen. Hydrogen is the lightest element on the periodic table. In the context of fasteners industry, with the mention of hydrogen we tend to have a mental picture of hydrogen embrittlement, the "cancer" of the fastener industry. I digress. We will stick to the more practical definition and move to the direction of materials and structures in the industry.

## LIGHTWEIGHT

# What are the materials that are considered as lightweight?

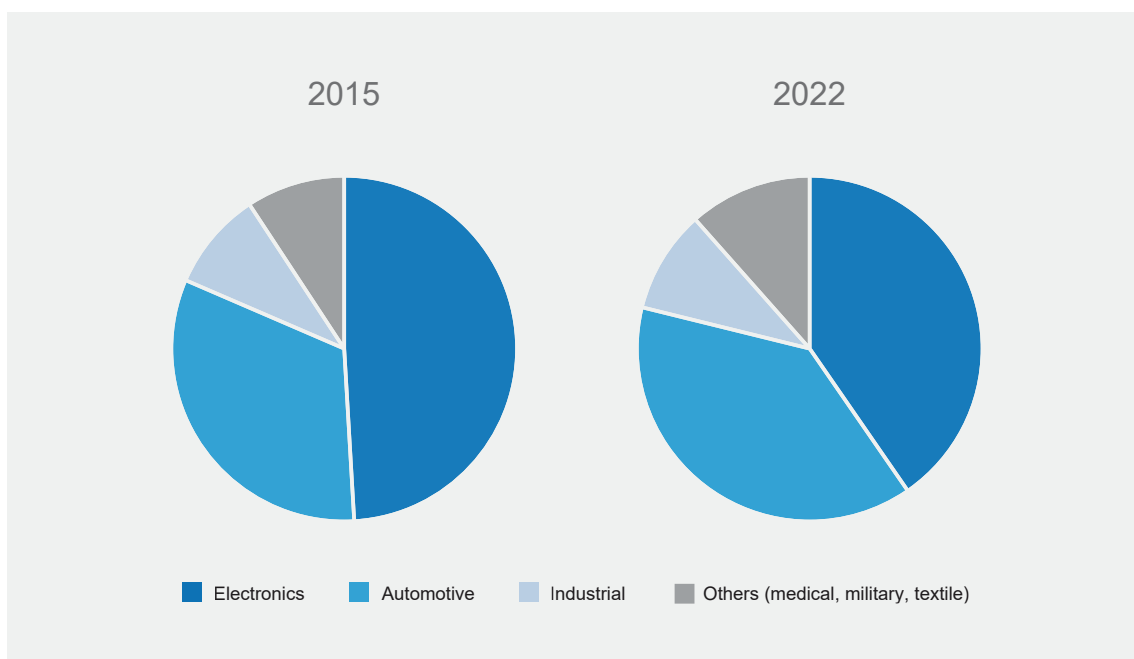
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The exotic materials such as titanium should pop up, and rightly so. This material has been used in the aerospace industry for many years and is now being used extensively in the bicycle industry for its strength to weight ratio and high temperature and corrosion resistance. Composite materials should come to mind as well. Fiberglass material has been in the boat making industry for some time now. A good friend in the industry mentioned that this was the reason bighead® was first created. Ken Stanley who recently passed on was the founder of bigHead Solutions. Back then, not so long ago in 1966, Ken was asked by a boat making friend at Bournemouth, England if he knew of any fasteners that does not require a hole. As you know, holes and boats do not go well together. This baffled Ken. His search in the industry came to naught. Ken decided that he should help out his friend and thus started the bigHead fastener that does not require a hole. The rest is history, definitely, "his story".

The successes and related applications of fiberglass materials led to much improved equivalents such as Kevlar and in the recent past, Carbon Fiber Reinforced Plastic, CFRP. Many tests were performed on such materials. Most indicated that the materials are strong, very flexible and could be moulded into intricate forms that a machined part or standard materials like aluminum are not possible or too expensive to fabricate. However, if holes are introduced into the CRF material, the strength of the material will be compromised and delamination may occur. Tests have showed that the significant loss of strength can be as high as 40%. This is definitely not good. Perhaps where possible, no holes should be introduced and if necessary, configuration of holes or hole patterns need to be investigated to ensure optimized strengths.

The use of CFRP in the industry is relatively new compared to steel, aluminum etc. Various companies have invested in such materials. Recently the automotive industry with the goals of greener environment has embarked on aggressive plans in this direction. Forefront in this direction is full battery or battery assisted vehicles. Due to limited and expensive battery costs, the drive (pun not intended) is to improve the distance by reducing the weight of cars.

Aerospace has been on lightweight path since the beginning of the industry. This is followed by the bicycle industry. Now, the automotive industry is taking the next big step from aluminum and magnesium to CFRP. For now, the limiting factor is price to weight ratio. With the increased use of this material, economics step in. More and more components will be looking into fabrications with the composite materials for the advantages of forming flexibility, strength and last but not least, lighter weight with respect to current materials.

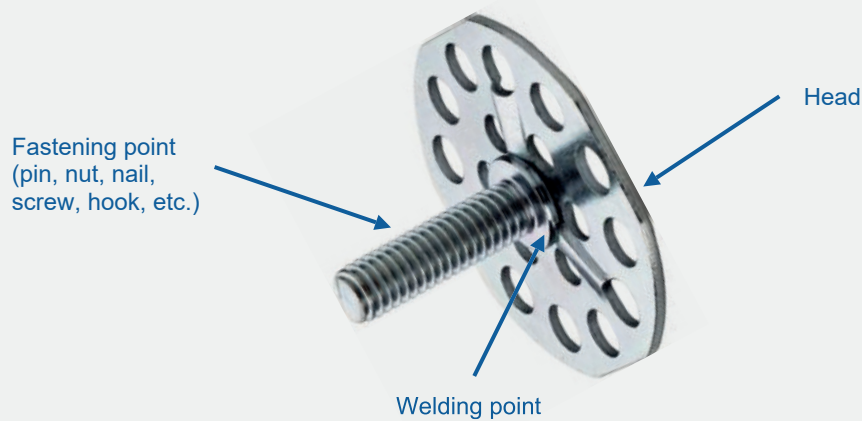


In this chart comparing the global lithium-ion battery market in 2015 and what's forecast for 2022, the electronics industry is the dominant consumer. (Courtesy of Allied Market Research)

## LIGHTWEIGHT

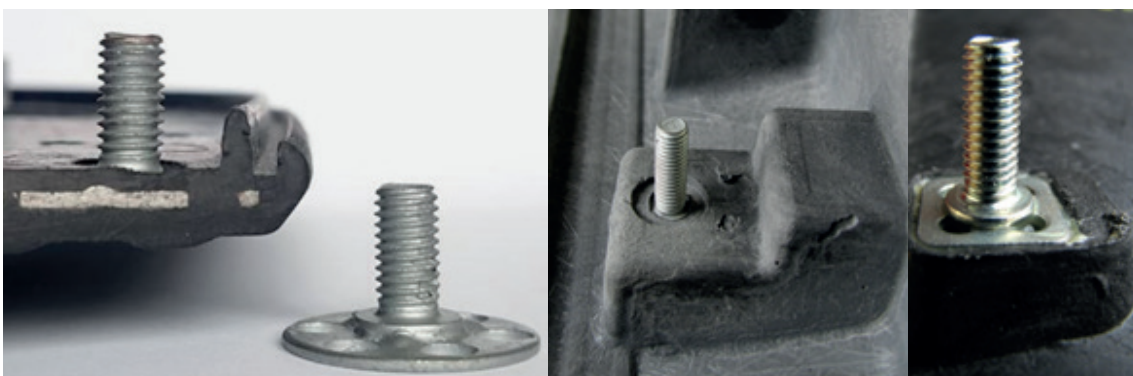
Bighead<sup>®</sup> solutions

From Ken Stanley's first fastening solution for fiberglass, the new CFRP materials can still make use of the bigHead<sup>®</sup> Solution. bigHead<sup>®</sup> Solutions work on the primary principle of a standard fastening "fixing" welded onto a "head" that can then be adhered to substrates.

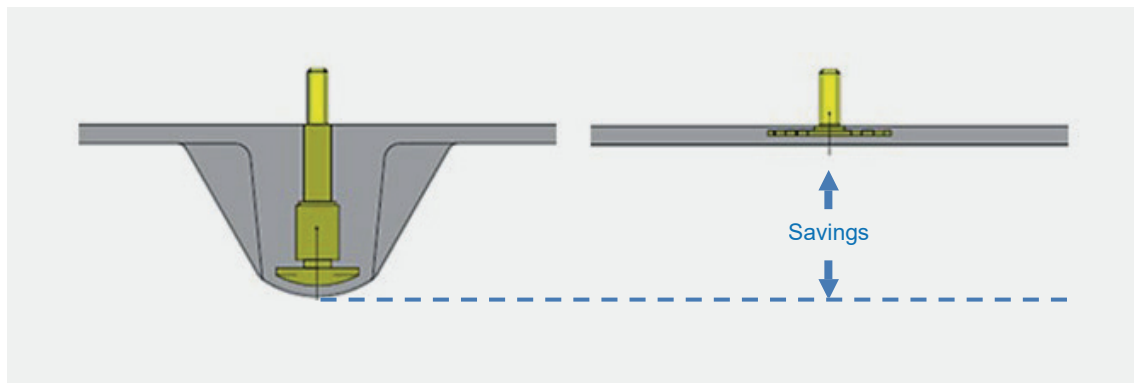


Note that bigHead<sup>®</sup> Solutions are used not only with CFRP but with other substrates such as steel, stainless steel, aluminum, glass, etc. All the designer needs to know is what type of fastening they want to have to find a bigHead<sup>®</sup> Solution to suit. Known properties can be obtained from the bigHead<sup>®</sup> website like tensile strength and weld strength.

Another option to adhesive is to embed the bigHead<sup>®</sup> Solution.



Traditional embedded fasteners require a great deal of plastic material to ensure application strengths, complicated tooling and high process time. With the use of bigHead® Solutions the design, expectations and fabrication becomes simplistic. Changes in strength no longer requires adding more plastic material, but instead can be achieved by increasing the head size of the bigHead® Solution. With this solution, the designer with the fabricator can improve the joint design in a faster and more simple manner. Complications such as lead time, process time and tooling changes are things of the past.



Ken's decision of welding the fixing to the head was to optimize the cost in fabricating the solution. Of course, machining the solution from a bar or block of material is another possibility, but more costly. Great care was taken ensuring that the welded joint is as good as or better than a machined solution. That has been the consistent quality level of bigHead® Solutions, no compromise there.

Friends of the industry often mentioned that the bigHead® Solution can easily be fabricated using simple equipment and standard parts. For sure, if you require 10 pieces today, another 10 a few weeks later, this is fine with no need to worry of quality consistency. But if you require mass production quantities and the high level of quality that is expected in today's quality-is-a-given scene, do the right thing. Do not go down the road of saving a few cents. Let bigHead® service you with known good solutions with state of the art process control and management. You will sleep well at night.

The bigHead® team slogan of "Liberating your Potentials" will allow engineers to open their design potentials to meet their expectations with expected quality level. Engineers do not need to compromise in their design in using traditional fastening solutions. They have bigHead® Solutions to meet their design requirements and expectations.



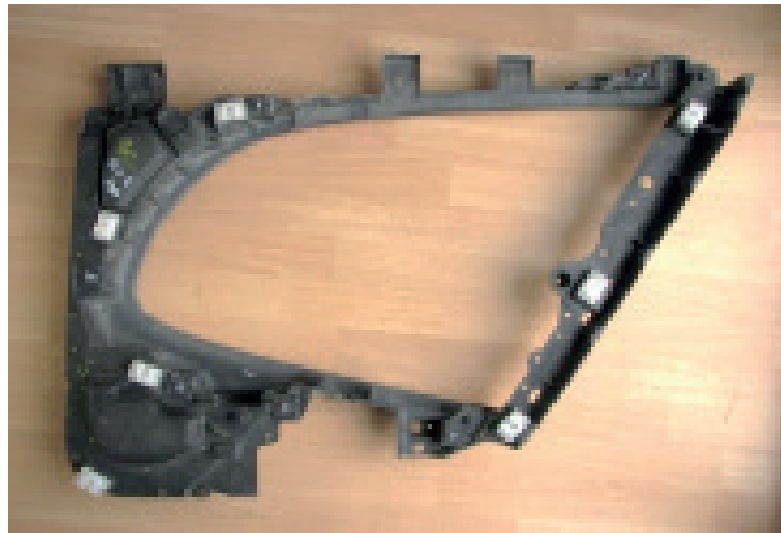
The use of bigHead® Solutions can encompass most industries. The situations could be, to name a few:

- No holes are possible
- Locations are not determined till later or
- Finish products aesthetics.

Often the questions arise such as, "What adhesive do we use so that it will be compatible to our design requirements?" To that, bigHead® has provided a set of guidelines for engineers to consider.

The other point often contested is, "It takes a long time to cure the adhesive". For this, bigHead® is in the process of coming out with an excellent "Lean Bonding" Solution integrating dry adhesive to bigHead® Solutions. The solution will include partnering with automation companies in collaboration to provide a one-stop solution for customers requiring a mass production solution with bigHead®.

With this fastening solution and team of bigHead® engineers to provide design services, our customers can then be truly envisioned as per bigHead® vision of "Liberating the Potentials" of their designs.



As mentioned, holes are not good for materials such as CFRP primarily because of material weakening. With larger forms at times it is inevitable that holes are necessary to integrate (fasten) other components or assemblies to the whole product. In such situations, the designer has to ensure that fastening solutions selected will not deteriorate the materials any further in terms of residual stresses. Residual stress at the hole circumference can lead to crack propagations and/or over compressive stress at the hole over time. For such situations, Bossard, in collaboration with our excellent partner, has the ecosyn®-BCT Solution to offer.



## LIGHTWEIGHT

# Ecosyn<sup>®</sup>-BCT

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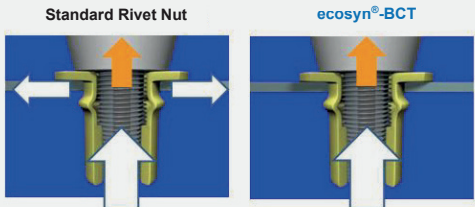
Similar to bigHead<sup>®</sup>, the unique ecosyn<sup>®</sup>-BCT Solution is the brain child of one person, Mr. Herbert Schruff, an engineer and entrepreneur. Herbert has recently passed on as well. BCT stands for Bulge Control Technology. The ecosyn<sup>®</sup>-BCT key benefits are that it will overcome limitations of existing rivet nuts in the market and has the capability to do more. The key differentiator is the implementation of strategically located holes at the circumference of the rivet nut body. That is just the starting point. Over 40 years of experience are put into good use to this simple yet excruciatingly frustrating process of fine tuning the solution to what it is today. We present to you the ecosyn<sup>®</sup>-BCT .

The knowledge and experiences in developing the ecosyn<sup>®</sup>-BCT resulted in four major standard offerings:

- Bulge Control
- Micro
- High Strength
- Multigrip

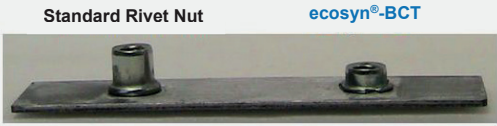
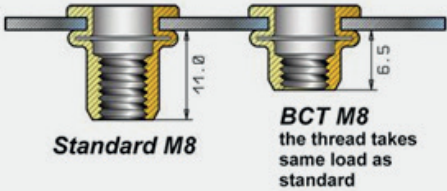
### Bulge control

This is the corner stone of the technology in particular for composite materials. With the strategically designed and located holes, the rivet nut body will deform at the specific location without the hole filling effect. This means that the prepared hole will not be stressed at all after assembly. This key differentiator is not available at the standard rivet nut in the market and thus brings forth application possibilities for composite materials with long term reliabilities.



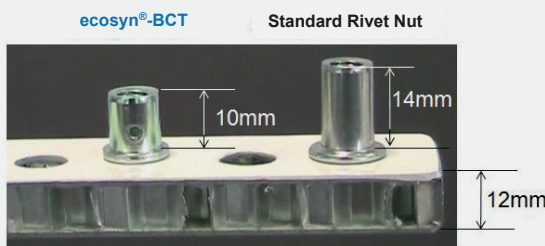
### Micro

Ever come across situations where you are not able to fit rivet nuts in limited space? The ecosyn®-BCT Micro is able to meet the expectations and maintain the expected strength after assembly. With this solution, engineers are able to assemble rivet nuts into tight space and even extrusions or tubing. Space limitations are no longer a problem, the impossible is now possible.



With Micro, limited space to house the rivet nut before assembly can be accomplished. For example, through small sized hollow sections. Cutting a rivet nut before assembly could be an answer but we sacrifice the strength of the rivet nut.

Another example is the newer aluminum honeycomb materials. Here the overall honeycomb material thickness is 12mm and you want to use a M6 Rivet with a hole on one side only. Standard M6 Rivet Nut Length before assembly is at 14mm. ecosyn®-BCT M6 Micro Length before assembly is at 10mm. Thus, ecosyn®-BCT Micro can be used directly without modifications to the material or design.



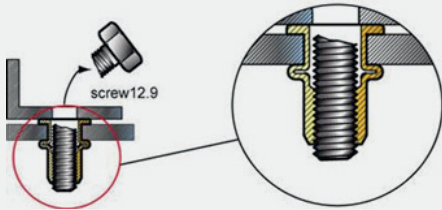
## High strength

The standard rivet nut strength in the market is often Property Class 8.8 (ISO 898). The ecosyn®-BCT High Strength is capable of handling fasteners up to Property Class 12.9. Our tests have demonstrated that the fastener can break due to overtightening but the ecosyn®-BCT will remain integral allowing the broken threaded portion of the fastener removal. This demonstrates the robust feature of the ecosyn®-BCT High Strength.

Application wise, this means that if the design requires a high strength assembly of a Property Class 10.9 or 12.9 fastener, standard rivet nuts in the market will not be able to meet the expectations. Designers will then have no choice but to fit in 2 standard rivet nuts to meet the expectations. With space limitations, this could be an added problem. With the ecosyn®-BCT High Strength, this can ease the burden of the design requirements.



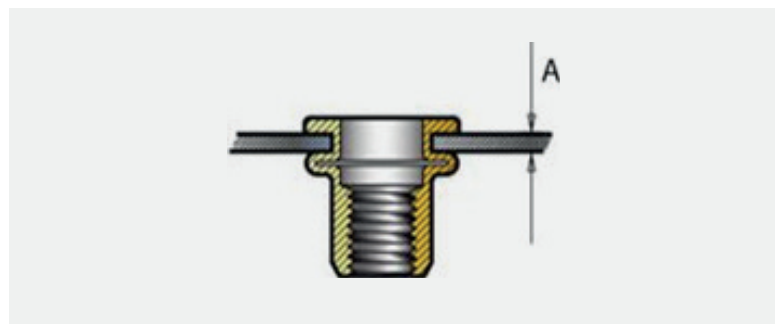
Aluminum bumpers are used more and more in the automotive industry. In order to manage galvanic corrosion coupled with high strength, BCT has created an aluminum rivet nut capable of handling fasteners at Property Class 12.9.



## Multigrip

This solution is excellent at aluminum, stainless steel and carbon steel materials. As most rivet nut users know, fastener size is the first determination of the application requirement. The next important variable is the grip length, the thickness of the substrate into which the rivet nut is installed.

With the ecosyn®-BCT Multigrip Solution, users can now have a much wider grip range for their application. More important is that the number of part numbers can be reduced.



Below is a well-known rivet nut brand and the grip lengths available. With ecosyn®-BCT Multigrip, you can observe that the grip length range can accommodate up to 4 part numbers. In practice, this means that error in selecting the right grip length rivet number is no longer an issue. No need to color code or use different location for parts to manage and control possible errors. Economy wise, with larger quantities, price can be negotiated.

### Well-known brand

	Part No. A	Part No. B	Part No. C	Part No. D
<b>M5</b>	from 0.25 to 2.0 mm	from 2.0 to 3.5 mm	from 3.5 to 5.0 mm	from 0.5 to 6.5 mm
<b>M6</b>	from 0.75 to 2.0 mm	from 2.0 to 3.5 mm	from 3.5 to 5.0 mm	from 0.5 to 6.5 mm
<b>M8</b>	from 1.0 to 3.0 mm	from 3.0 to 5.0 mm	from 5.0 to 7.0 mm	from 7.0 to 9.0 mm
<b>M10</b>	from 1.0 to 3.0 mm	from 3.0 to 5.5 mm	from 5.5 to 8.0 mm	from 8.0 to 10.5 mm
<b>M12</b>	from 1.0 to 3.0 mm	from 3.0 to 5.5 mm	from 5.5 to 8.0 mm	from 8.0 to 10.5 mm

### ecosyn®-BCT

	Part No. A
<b>M5</b>	from 0.25 to 2.0 mm
<b>M6</b>	from 0.25 to 2.0 mm
<b>M8</b>	from 0.25 to 2.0 mm
<b>M10</b>	from 0.25 to 2.0 mm
<b>M12</b>	from 0.25 to 2.0 mm

The above four mentioned ecosyn®-BCT Solutions are but a simple manner of expressing the capabilities of Mr. Herbert Schraff's vision of the technology. With the combination of these solutions, we are able to solve a myriad of common problems to meet the industries expectations and challenges. The possibilities are limited only by our imaginations. Contact us with your challenges. We are confident that if it is a fastening requirement, we have the solution.



## LIGHTWEIGHT

# Summary

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The possible solutions that were discussed are current, available and proven. They will not take the place of the common nuts, bolts and washers, but should be considered when designing with newer, lightweight materials to ensure the best and most economical design possible.

The lightweight industry road map has created many challenges to the industry including fastening industry. Bossard and strategic partners in the industry have been keeping a close watch of the industry progress keeping us and our services relevant in the industry.

Standard fastening solutions must always be a first choice with good reasons. For that to happen, fastening choices should be kept in mind at the onset of initial design phase in order that the final component can be assembled as intended. That way, it will lead to the initial intents. Of course, I do not expect automotive designers to think of fasteners first before they embark on their new electric car with wings but at least keep in mind that the components of the cars need to be assembled or put together. The simple things in life are not that simple after all.

With the onset of new materials where standard fasteners cannot meet the expectations the process remains the same but with an added step of engaging fastening experts like Bossard. With our engineers, their vast accumulated experiences and “Proven Productivity” we will be able to provide solutions that will best fit the requirements. At the very least we can tell you what is not possible, and point you in the right direction early in your design phase before it’s too late to make changes!



If you need further assistance or have special finish requirements, please check out our contact page at [www.bossard.com](http://www.bossard.com) and talk to your nearest Bossard customer service representative.